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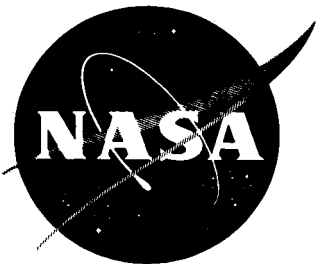
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ABSTRACT

23032

"1962 Publications" is a compilation of official abstracts of reports, written by personnel of the Engineering Materials Branch, released during 1962.

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1962 PUBLICATIONS

By

Engineering Materials Branch

ENGINEERING MATERIALS BRANCH
PROPULSION AND VEHICLE ENGINEERING DIVISION

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GEORGE C. MARSHALL SPACE FLIGHT CENTER

MTP-P&VE-M-63-1

1962 PUBLICATIONS

By

Engineering Materials Branch

SUMMARY

This report lists and summarizes the Marshall Technical Papers and Internal Notes written by personnel of the Engineering Materials Branch, Propulsion and Vehicle Engineering Division, George C. Marshall Space Flight Center, National Aeronautics and Space Administration during 1962.

~~INTRODUCTION~~

The mission of the Engineering Materials Branch is to conduct research and development in the fields of chemistry, metallurgy, chemical engineering, physics, and other technologies related to materials in research and engineering. These investigations are conducted in support of the launch vehicle programs of the George C. Marshall Space Flight Center. This report lists and summarizes the technical reports written by personnel of the Engineering Materials Branch during 1962.

23032

Author

Requests for additional copies of these reports designated by the report number should be addressed to:

George C. Marshall Space Flight Center
Huntsville, Alabama
Attention: M-MS-IPL

MARSHALL TECHNICAL PAPERS

January 25, 1962

1961 PUBLICATIONS

MTP-P&VE-M-62-1

Engineering Materials Branch

Unclassified, 25 pages

This report lists and summarizes the Marshall Technical Papers, Internal Notes, and a special Marshall Progress Report written by personnel of the Engineering Materials Branch, Propulsion and Vehicle Engineering Division, George C. Marshall Space Flight Center, National Aeronautics and Space Administration during 1961.

January 25, 1962

VACUUM LUBRICATION

MTP-P&VE-M-62-2

K. E. Demorest

Unclassified, 25 pages, 1 table, 10 figures

The problem of lubrication of guidance, control, and instrument-type bearings in space is under comprehensive study. This report describes the apparatus used in the study, the environment in which evaluations of inorganic dry film lubricants are being made, and a mathematical model designed to describe the failure mode observed in actual testing. The method of total problem solution is described, and the status of current work is discussed in detail. It is noted that, although the problem is not solved, solution can be expected in a reasonable period of time.

February 14, 1962

CORROSION SUMMARY OF THE H-1
ENGINE AFTER THE SEA IMMERSION
TEST PROGRAM

MTP-P&VE-M-62-3

R. H. Higgins

Unclassified, 26 pages, 1 table, 5 figures

Sea water immersion tests were conducted on a Rocketdyne H-1 engine in order to evaluate the corrosive effects of sea-water recovery on the engine and to define the procedures necessary to restore the engine for flight service. This program involved a series of tests in which the H-1 engine was immersed in sea water for given periods of time, followed by various post treatments designed to minimize the corrosive effect of sea water. The engine was then disassembled, evaluated for corrosion damage, reassembled, and test fired.

These tests showed that the sea water caused varying degrees of corrosion on some engine components. This corrosion was minimized to some extent by post-recovery treatments. This included immediate flushing of external surfaces and internal systems with fresh water and a corrosion preventative, water-displacing type of oil. Complete disassembly and extensive cleaning of all components were required prior to reuse of the engine. A few of the components were replaced, either due to excessive corrosion or as a matter of caution.

Although the nature of this engine limits the protective measures possible for this type of environment, several modifications to the engine would enhance its resistance to sea-water corrosion. Also, further studies would be conducted for the development of more satisfactory post-recovery procedures, if this method of recovery is to be pursued.

February 23, 1962 AN APPARATUS FOR THE MEASUREMENT MTP-P&VE-M-62-4
 OF THE TOTAL NORMAL EMITTANCE
 OF SURFACES AT LOW TEMPERATURES

G. A. Zerlaut

Unclassified, 29 pages, 2 tables, 9 figures

This report discusses the theory, design and test results achieved with a device that measures total normal emittance of surfaces at temperatures in the 0-100°C range. The black body, and sample, used in the device are housed in a vacuum chamber (1.6×10^{-4} Torr.). Attached to the vacuum chamber is an evacuated radiometer. For a detector, a well-baffled, 28-junction, iron-constantan, radial thermopile was built. In use, the total emittance is measured as the ratio of the thermoelectric EMF generated by the sample to the thermoelectric EMF generated by the black body, at the same temperature and pressure. The thermopile output was determined to be 150 microvolts per Btu/ft²-hr at black body temperatures of 340°K or greater. The device can be modified for measuring total normal emittance at high temperatures; however, the selectivity of the thermopile receiver, plus lack of sufficient energy at low temperatures, may preclude the measurement of emittance at cryogenic temperatures.

March 6, 1962 STUDIES ON THE RELIABILITY MTP-P&VE-M-62-5
 OF PARTICULATE CONTAMINATION ANALYSES

J. B. Gayle and J. O. Romine

Unclassified, 31 pages, 4 tables, 4 figures

Selected factors influencing the reliability of results of particulate contamination analyses have been investigated. These include the method of purging the sample valves and the type of microscope used. Also, the inherent variability of the test method and the variations introduced during the sampling and testing operations have been considered. Estimates of the standard deviations of particle counts are given for samples taken from a typical ground service hydraulic system. These vary with the number of particles actually counted and range from approximately 30 percent for very high counts to 50 percent for very low counts.

March 5, 1962 AGING OF INSTALLED RUBBER AND PLASTIC MTP-P&VE-M-62-6
GASKETS IN SIMULATED FLIGHT HARDWARE

S. L. Burt, J. M. Stuckey, L. M. Thompson

Unclassified, 76 pages, 17 tables, 11 drawings, 4 test procedures, 10 figures

A study of the combined effect of time and atmospheric conditions (ambient temperature, humidity, and oxidation) on the functional reliability of selected gasket materials was begun in April, 1959.

Initially, eight types of rubber, three plastics, and four commercial gaskets (metal and rubber o-rings, Flexitallic, and Allpax) were installed as static seals in conventional flange connectors (bolted and Marman types). Dynamic sealing in three types of solenoid operated valves equipped with rubber o-ring seals was included in the study. Each type of rubber is being tested in two shapes, namely, o-rings and flat gaskets.

Pressurization testing of installed gaskets for leakage rate measurements was run semiannually.

Accelerated ozone aging, air bomb aging, and compression set tests were carried out in the laboratory for determining the relative age resistance of several types of rubber, and these tests provided a means of measuring the progress made in the development of improved age resistant stocks. Outdoor weathering tests were run parallel with accelerated laboratory testing to further advance the meager understanding of correlating the results of these two methods of testing.

Currently, thirteen types of rubber are being tested. The installed gasket program, in progress at the Marshall Space Flight Center, is duplicated exactly at Gainesville, Florida under contract with the University of Florida (Contract NAS8-1523).

This report covers the activities during the first two and one-half years of the aging program. Flexitallic gaskets in aluminum flanges

failed the 750 psi pressure test after six months at MSFC (one year at Gainesville, Florida) of installed life. Flexitallic gaskets in stainless steel flanges failed after one and one-half years of installed life at both locations. Allpax gaskets, tested at 500 psi pressure, failed the initial test at MSFC and after two years at Gainesville. None of the rubber (commercial or domestic) or plastic gaskets have failed the pressure test due to aging during the time interval covered by this report.

April 2, 1962

A STUDY OF THE OUTGASSING
AND EVAPORATION PRODUCTS OF SOME
MATERIALS UPON EXPOSURE TO REDUCED PRESSURE

MTP-P&VE-M-62-7

S. V. Caruso and W. C. Looney

Unclassified, 51 pages, 2 tables, 26 figures

A technique has been developed which allows identification and differentiation of the outgassing and evaporation products resulting from the exposure of a material to reduced pressure. The experimental approach entails collection of the outgassing and vaporization products in a special chamber, then examination of the collected vapors with a mass spectrometer. Since the time of collection can be extended indefinitely, even materials with extremely low vapor pressures and/or outgassing rates can be studied.

The outgassing and evaporation products of two pure materials (glycerine and dibutyl phthalate), two lubricants (Fluorolube T-45 and Rockwell 950), two solid propellants (normal polybutadiene acrylic acid and Flexadyne, a modified polybutadiene acrylic acid), and seven elastomers (natural rubber, silicone rubber, Buna-N, Viton A, neoprene, butyl rubber, and Kel-F) were collected and analyzed.

All of the materials investigated released adsorbed moisture; the adsorption and subsequent release of other atmospheric constituents depend upon the chemical structure of the material. The two pure compounds, the lubricants, the solid propellants, and the natural rubber endured losses in weight from both outgassing and evaporation; the other elastomers examined lost only adsorbed atmospheric constituents.

Evaporation rates, determined by continuous weighing of the sample while exposed to reduced pressure, correlate with the results obtained from the mass spectrometric examination of the outgassing and vaporization products.

May 8, 1962

EVALUATION OF SPERRY
ULTRASONIC PARTICLE COUNTER

MTP-P&VE-M-62-8

J. B. Gayle and W. A. Riehl

Unclassified, 32 pages, 3 tables, 9 figures

The ultrasonic counter has been evaluated to determine its suitability for inline monitoring of continuously operating hydraulic systems. The investigation was carried out by circulating fluid, representing widely varying levels of particulate contamination, through a laboratory hydraulic system operating at a pressure of approximately 50 psi and a temperature of 70°F. Samples were withdrawn from the system at frequent intervals for microscopic analysis. It was found that the ultrasonic counts have a satisfactory degree of precision, are unaffected by moderate variations in flow rates, and are closely correlated with the microscopic counts. Therefore, it was concluded that the ultrasonic counter is well suited for contamination analyses for particle sizes falling within the range of instrument capabilities.

It should be noted, however, that satisfactory performance was obtained only after some modification of the counter and that additional tests are needed to evaluate its performance at elevated temperatures and pressures.

May 16, 1962

COMPUTER PROGRAM FOR REDUCTION
OF NEUTRON ACTIVATION FOIL DATA

MTP-P&VE-M-62-9

L. K. Zoller

Unclassified, 135 pages, 1 table, 2 figures

In order to provide a rapid, consistent, and accurate means for reducing and organizing "raw" foil counting data from neutron activation foils, a computer program has been written for utilization on the IBM 704 and 7090 digital computers. This computer program features flexibility to provide for nearly all commonly encountered data acquisition and data reduction techniques. Further, it is designed to provide the maximum information obtainable from the input data in the event that a program "stop" is encountered.

June 14, 1962

CRITIQUE ON AVAILABLE NUCLEAR
RADIATION EFFECTS DATA

MTP-P&VE-M-62-10

L. K. Zoller

Unclassified, 45 pages, 5 tables

A recent study of literature pertinent to the nuclear radiation effects on materials was conducted in connection with the radiation effects program in the Engineering Materials Branch. This survey revealed deficiencies in data determination and documentation which diminished the usefulness of application of this previous work to the current program. Frequently omitted are such obvious details as facility and test description, sample specifications, an account of techniques used in performing the mechanical tests, and a complete description of the test environment. Also, all too often, little or no information is provided for interpretation of mechanical or physical properties, or changes in these properties, reported in terms of integrated doses.

It is axiomatic that, although relative data may suffice for immediate needs, completeness is tantamount to maximum value of reported data. To ensure that reported data are sufficiently complete to facilitate thorough analysis of the experiment, it is essential that the experimenter determines and defines all of the test characteristics and parameters. This critique on radiation effects data is presented (1) to point out some of the deficiencies in existing literature, and (2) to suggest guidelines for clarity, completeness, and consistency in future publications in an effort to ensure the maximum benefit is received from the results of all work done in this field.

June 9, 1962

CALIBRATION OF DIATRON-20 RESIDUAL MTP-P&VE-M-62-11
GAS ANALYZER FOR USE IN HIGH
VACUUM SYSTEMS

S. V. Caruso

Unclassified, 26 pages, 4 tables, 5 figures

Rapid developments in ultrahigh vacuum techniques have brought about the need for more accurate low pressure measuring devices. In the current state of the art, mass spectrometers are being used to indicate residual gas pressure and to analyze volatile components in vacuum systems. However, since conventional sampling and calibrating methods are impractical in such systems, problems are encountered in obtaining accurate calibration of spectrometers.

A method for calibrating a Diatron mass spectrometer is described in this report. The procedure is based on the diffusion of gases through a single polymer membrane (1/32-inch thick Teflon). The leak standard is first calibrated on an analytical mass spectrometer (CEC 21-620) in CC(STP)/sec. for several gases. The apparatus then is used to determine the sensitivity of a Diatron mass spectrometer (CEC 133562) for the gases. This method provides a single leak rate standard for various gases. The

reproducibility of replicate determinations is approximately ± 3 percent, which is within the limits of mass spectrometry techniques. In addition, the combination of the large membrane surface area and mechanism of gas diffusion through a polymer eliminates the problem of frequent plugging of microscopic orifice types of standards. This method also can be used for other gases that permeate a polymer diaphragm.

November 6, 1962

COMBINED ENVIRONMENTAL EFFECTS
ON NUCLEAR ROCKET MATERIALS

MTP-P&VE-M-62-12

E. E. Dungan

Unclassified, 130 pages

This report is a compilation of the separate effects of nuclear radiation, high vacuum, and cryogenic temperatures on the mechanical and physical properties of engineering materials. The significance of a synergistic effect on material properties as a result of combined environmental exposure is demonstrated, and the need for extensive experimental investigations of these combined environmental effects is emphasized. Current experimental programs are described and future requirements of advanced nuclear rocket systems are discussed.

November 30, 1962

REACTIVITY OF TITANIUM
WITH OXYGEN

MTP-P&VE-M-62-13

W. A. Riehl, C. F. Key, J. B. Gayle

Unclassified, 75 pages, 34 tables, 36 figures

The reactivity of titanium with oxygen was studied by several test methods and under a variety of conditions associated with space vehicles.

Titanium is highly sensitive to impact in contact with LOX and this method was used to study the effects of surface treatments, coatings, and numerous other factors upon the reactivity. The comparative reactivities of titanium, aluminum, and stainless steel alloys with oxygen were investigated by impact, shock, puncture, and spark sensitivity testing. Punctures resulting from bullets, darts, pins, or artificial meteoroids usually caused explosions. Coatings which reduced titanium reactivity in impact or shock tests were not beneficial under puncture conditions. Aluminum and stainless steel failed to react on impact or puncture.

The shock stimuli produced by small detonator caps alone were sufficient to initiate explosive reaction of titanium in contact with

oxygen. An extremely heavy shock was necessary to cause aluminum to react under the same test conditions, and stainless steel did not react under the most drastic shock conditions employed. The titanium/oxygen combination is considerably more susceptible to spark initiation than aluminum/oxygen. A comparatively high energy spark was necessary for reaction of 0.010-inch thick sheets of titanium with oxygen.

Under the particular test conditions used, titanium was insensitive to reaction with oxygen when subjected to vibration, pressure cycling, or pressurization of thin-walled tanks containing LOX to rupture.

December 19, 1962 DEVELOPMENT OF A HIGHLY REFLECTIVE MTP-P&VE-M-62-14
UNFIRED CERAMIC THERMAL INSULATION

V. F. Seitzinger

Unclassified, 28 pages, 4 tables, 9 figures

A nonflammable, composite, insulation material was developed for protecting the base of the booster stage of the Saturn launch vehicle. The system consists of an unfired, highly reflective, inorganic insulating coating. The coating, designated as M-31, is prepared from fibrous potassium titanate, asbestos fibers, and colloidal silica. It has good thermal shock and erosion resistance and excellent moisture resistance. The material development is described, and selected thermal, optical, and mechanical properties of the coating are reported.

December 19, 1962 A RADIANT HEAT SOURCE IN A MTP-P&VE-M-62-15
SIMULATED ALTITUDE ENVIRONMENT

F. Uptagrafft, H. M. King, W. N. Clotfelter

Unclassified, 20 pages, 9 figures

This report discusses a radiant heating device. The device has met successfully the goals established at the initiation of the development which are listed as follows:

- a. Develop radiant heat fluxes up to 100 Btu/Ft.² sec.
- b. Concurrent with the generation of these heat fluxes, simulate the environments to which a launch vehicle is exposed during ground and flight testing. This is to include vibration and pressure.
- c. Be capable of operating for times in excess of five minutes.

d. Be fully instrumented to record automatically heat flux, pressure, and specimen temperatures.

The detailed development steps are discussed, and the device design is described.

December 19, 1962 EVALUATION OF WELDED 2219-T87 MTP-P&VE-M-62-16
ALUMINUM ALLOY

R. A. Davis

Unclassified, 30 pages, 3 tables, 16 figures

A program to determine weld strength design allowables and other welding information for aluminum alloy 2219-T87 is reported herein. This program was conducted in support of the Saturn S-IC.

Metal arc, inert gas shielded (MIG) welds and tungsten arc, inert gas shielded (TIG) welds, were evaluated in plate thicknesses of 1/4, 1/2, 3/4, and 1 inch for aluminum alloy 2219-T87. Welds, by each process and in each thickness, were produced in the flat, vertical and horizontal welding positions. Plate, 2 inches thick, was welded by each process in the flat position only.

Studies were conducted to determine the extent of weld heat affected zone into the base metal. A value of 1-3/8 inches from the centerline of the weld is given as a maximum extent of heat affected zone, if proper joint design and welding process are employed.

Ultimate strength data of welds were statistically analyzed by Students' "t" test, assuming the data conformed to a normal distribution. Both 95 and 99 percent confidence levels were determined for TIG welds, MIG welds, and the combined MIG and TIG welds. TIG welds were more consistent in strength, slightly higher in ultimate strength values, and exhibited better weld quality (more sound) than MIG welds.

December 28, 1962 ELECTRICAL CONTACTS IN VACUUM MTP-P&VE-M-62-17
(A) BRUSHES: STATUS REPORT NO. 2

J. C. Horton

Unclassified, 23 pages, 11 figures

This is the second report on the program to develop electrical brushes for use in vacuum. Test results on hot-pressed molybdenum

disulfide/metallic powder brushes under simulated conditions, and in actual use in a motor, are given. The basic structure and the electrical characteristics of these brushes are discussed in detail, and a theory for their conductivity is developed.

INTERNAL NOTES

February 19, 1962 CRITIQUE ON AVAILABLE NUCLEAR IN-P&VE-M-62-1
RADIATION EFFECTS DATA

L. K. Zoller

Unclassified, 40 pages, 5 tables

As a result of a survey of literature pertinent to the nuclear radiation effects on materials, a number of deficiencies in the determination and documentation of data was noted. Major deficiencies are delineated in this report along with exemplary calculations to demonstrate the magnitude of errors likely to be introduced through misinterpretation of the reported data. This critique on radiation effects data is culminated with recommendations for obtaining and reporting data, and the need for a comprehensive empirical/theoretical, in-house radiation effects program to supplement and complement experimental programs already outlined by the Engineering Materials Branch.

April 2, 1962 WELDABILITY STUDIES OF 5456-H343 IN-P&VE-M-62-2
AND 2219-T87 ALUMINUM ALLOY PLATES

C. E. Cataldo

Unclassified, 41 pages, 15 tables, 13 figures

A test program to compare certain properties of two high strength aluminum alloys, 5456-H343 and 2219-T87, is described. Based on the results of this program, it was recommended that alloy 2219-T87 be used for the major structural material for the Saturn S-IC vehicle.

May 5, 1962 LOW TEMPERATURE MECHANICAL PROPERTIES IN-P&VE-M-62-3
OF X-2020-T6 AND 2219-T6 ALUMINUM
SHEET ALLOYS

C. V. Lovoy

Unclassified, 16 pages, 4 tables, 3 figures

The mechanical properties of X-2020-T6 and 2219-T6 at cryogenic temperatures were determined in order to evaluate their potential structural application. Primary consideration was given to sheet materials because of their use as space vehicle skins, pressure vessels, and cryogenic fluid transfer ducts.

May 28, 1962 LOW TEMPERATURE MECHANICAL PROPERTIES IN-P&VE-M-62-4
 OF A-286 ALLOY AND ITS WELDMENTS

W. R. Morgan

Unclassified, 21 pages, 4 tables, 5 figures

The mechanical properties of A-286 alloy sheet in the annealed and precipitation or age-hardened condition were determined at temperatures from ambient to -423°F . The parent metal in both conditions increased in ultimate tensile and yield strength with a decrease in temperature over the temperature spectrum of 80°F to -423°F . The percent elongation of the parent metal increased to a maximum at a temperature of -320°F . At -423°F , the percent elongation was approximately the same as ambient temperature elongation. The notched/unnotched tensile ratios for the parent metal decreased with a decrease in temperature. The properties of the age-hardened weldments are compared to those of the parent metal and the as-welded butt joints. The tensile strengths of the three weld conditions tested increased with a decrease in temperature, and the tensile strengths of the weldments with post weld heat treatment were consistently higher than the as-welded specimens of annealed and age-hardened base alloy over the temperature range of 80°F to -423°F .

July 24, 1962 LOW TEMPERATURE MECHANICAL PROPERTIES IN-P&VE-M-62-5
 OF INCONEL X AND ITS WELDMENTS

C. V. Lovoy

Unclassified, 20 pages, 6 tables, 6 figures

The mechanical properties of Inconel X and its weldments were determined at temperatures from 80°F to -423°F . The alloy has favorable tensile, yield, and toughness values at all temperatures down to -423°F . The tensile and yield strengths of its weldments (age-hardened) are equivalent to or greater than those obtained from age-hardened parent metal. However, caution should be exercised where it is not possible to age-harden after welding.

The relatively low yield strength (48,000 psi at 80°F) practically eliminates the use of annealed Inconel X in structural applications except in those cases where a high strength/density material is not the criterion for material selection.

July 24, 1962 LOW TEMPERATURE MECHANICAL PROPERTIES IN-P&VE-M-62-6
 OF RENE' 41 ALLOY AND ITS WELDMENTS

P. C. Miller

Unclassified, 19 pages, 6 tables, 4 figures

The mechanical properties of Rene' 41 alloy sheet in the annealed and age-hardened conditions were determined at temperatures from ambient to -423°F. The mechanical properties of the material in both conditions were not altered significantly by rolling direction. Strength increased with decrease in temperature, with the age-hardened alloy showing superiority for parent alloy and weldments over the temperature spectrum of 80°F to -423°F.

Composite weldments of age-hardened Rene' 41 alloy and annealed 321 alloy were revealed to have good mechanical properties. Weld joint efficiency was 90% or better, and a minimum elongation of 13% was obtained over the temperature range of 80°F to -423°F.

August 3, 1962 INVESTIGATION OF THE CORROSION IN-P&VE-M-62-7
 OF ALUMINUM FLANGES ASSOCIATED WITH
 ALLPAX NO. 500 GASKET MATERIAL

E. E. Nelson and J. G. Williamson

Unclassified, 13 pages, 4 figures

As a result of corrosion found on aluminum flanges associated with Allpax gaskets, tests were initiated to determine the cause of this corrosion. These studies indicated that Allpax No. 500 gasket material can cause corrosion on aluminum flanges under humid conditions. Several characteristics of the material appear to be responsible for this condition; the alkaline nature of the material, the graphite coating used for gasket release, and the ability of the material to absorb and retain moisture. Tests indicate that this corrosion can be greatly reduced or retarded if the flanges are anodized or given a chemical conversion coating.

August 28, 1962 LOW TEMPERATURE MECHANICAL PROPERTIES IN-P&VE-M-62-8
 OF K-MONEL ALLOY AND ITS WELDMENTS

W. R. Morgan

Unclassified, 23 pages, 5 tables, 5 figures

The mechanical properties of K-Monel parent metal (0.063-inch thick) and its weldments were determined at temperatures from ambient to -423°F . The tensile properties were not affected significantly by rolling direction. The tensile properties of both parent metal and its weldments increased continuously with a decrease in temperature. The tests indicated that the alloy has good notched tensile properties in both the annealed and heat-treated conditions over the temperature range of 80°F to -423°F . Weldments are compared in the following different practical heat-treated conditions: Of annealed, as welded; age-hardened, as welded; and annealed, then welded, followed by age-hardening heat treatment. The results show that with proper design application, K-Monel alloy and its weldments can be employed safely for space vehicle systems exposed to temperatures from 80°F to -423°F .

October 5, 1962 MECHANICAL PROPERTIES OF 2219-T87 IN-P&VE-M-62-9
 ALLOY PLATE AT ROOM AND
 CRYOGENIC TEMPERATURES

W. R. Morgan

Unclassified, 17 pages, 2 tables, 6 figures

The mechanical properties of 2219-T87 alloy plate (2 inches thick) were determined at temperatures from ambient to -423°F . The ultimate tensile and yield strengths for the three directions tested (longitudinal, transverse, and diagonal) increased continuously as the temperature decreased, reaching a maximum at -423°F . The transverse direction of the alloy plate had the lowest elongation (expressed as percent in a 2-inch gauge length) of the three directions tested and remained almost constant over the temperature spectrum of 80°F to -423°F . The notched/unnotched tensile ratio decreased with a decrease in temperature. The tensile properties throughout the thickness of the plate were compared to the surface properties.

October 19, 1962 LOW TEMPERATURE MECHANICAL PROPERTIES IN-P&VE-M-62-10
 OF MAGNESIUM-LITHIUM ALLOYS LA 91
 AND LA 141

O. Y. Reece

Unclassified, 30 pages, 8 tables, 10 figures

Low temperature mechanical properties of magnesium-lithium alloys LA 141 and LA 91 were determined in the temperature range of 75°F to -423°F . Ultimate tensile strength of alloy LA 141 increased from 19,700 psi at room temperature to 42,900 psi at -423°F , and ultimate tensile

strength of alloy LA 91 increased from 23,000 psi to 45,900 psi at the same respective temperatures. Both alloys retained good ductility at all temperatures.

Ultimate strengths of transverse weldments of both alloys were slightly lower than those of the parent metal at very low temperatures.

LA 91 appeared to be somewhat notch sensitive at very low temperatures; however, the notched tensile strength exceeded the yield strength at all temperatures except -423°F.

Both alloys appear to be satisfactory for ambient and low temperature structural applications where low to moderate stress levels are to be encountered.

October 25, 1962 SHORT-TIME, ELEVATED TEMPERATURE IN-P&VE-M-62-11
MECHANICAL PROPERTIES OF 5456-H343
ALUMINUM ALLOY

J. W. Montano and W. B. McPherson

Unclassified, 26 pages, 3 tables, 11 figures

The mechanical properties of 5456-H343 aluminum were determined after soak times from 0 to 300 seconds, at temperatures from ambient to 600°F. The tensile strength of the 5456 aluminum decreased with increasing temperature. In general, the tensile properties were not significantly influenced by variations in soak times (within the limits of the program) up to 500°F. At 600°F, variations in soak time noticeably affected the strength. This material, therefore, seems to be stable, microstructurally, only to 500°F under the testing conditions employed. The strength deterioration at 300°F, however, would prohibit load-bearing applications much above 300°F.

November 28, 1962 STUDY OF SELECTED FACTORS IN-P&VE-M-62-12
INFLUENCING THE PERFORMANCE
OF INTERNAL DESTRUCT SYSTEMS
USING PRIMACORD

J. B. Gayle

Unclassified, 36 pages, 23 figures

Selected factors influencing the performance of internal destruct systems using Primacord as the explosive component have been investigated. In particular, the effects of propellants (RP-1 and LOX) accidentally

coming into contact with the Primacord, and of the low temperature environment were investigated. The results failed to indicate any deleterious effects except in the case of LOX coming into contact with the polyethylene outer sheath of Primacord. Inasmuch as polyethylene is not qualified for LOX service, added protection, possibly in the form of a supplementary outer sheath of Teflon, is indicated for any Primacord application wherein contact with LOX is considered probable.

November 28, 1962 FREEZING OF LIQUIDS ON SUDDEN IN-P&VE-M-62-13
EXPOSURE TO VACUUM

J. B. Gayle and C. T. Egger

Unclassified, 24 pages, 2 tables, 5 figures

An analytical study is presented of evaporative cooling and freezing of liquids exposed to high vacuum. Preliminary consideration of the mechanism of the process resulted in a complex mathematical model. Therefore, it was necessary to make a number of simplifying assumptions to establish material and energy balances which were used, along with kinetic theory of gases, as a basis for calculations.

Results given for several cryogens and water indicate the effects of initial temperature, drop diameter, and ambient pressure on the time required for cooling to the triple point and subsequent freezing.

December 19, 1962 THE EFFECTS OF ROLL-REDUCTION AND IN-P&VE-M-62-14
STRETCHING ON THE MECHANICAL
PROPERTIES OF ALUMINUM ALLOY 2219

C. V. Lovoy

Unclassified, 24 pages, 7 tables, 6 figures

The effects of deformation, by roll-reduction and stretching, upon the mechanical properties of aluminum alloy 2219 sheet and plate were determined. Three material thicknesses, 0.090 inch, 0.250 inch, and 0.750 inch were investigated. Each thickness was subjected to cold working by roll-reduction and by stretching, and tested prior to aging and after aging. No appreciable mechanical property differences were noted with respect to material thickness.

Tensile tests on rolled and stretched 2219-T42 revealed an appreciable increase in ultimate tensile and yield strengths with increasing cold work between 1 percent and 15 percent. However, the elongation decreased with increasing cold work.

Artificial aging, upon completion of a cold-working operation, led to even higher strength levels. However, the optimum mechanical properties of each cold-working method were realized at 10 percent roll-reduction and a 2-1/2 percent stretch operation. Additional roll-reduction of the -T42 temper beyond 10 percent or stretch operation greater than 2-1/2 percent, prior to aging, resulted only in a gradual loss of ductility with a negligible change in ultimate tensile and yield strengths.

APPROVAL

MTP-P&VE-M-63-1

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By

Engineering Materials Branch

The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.



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